

Evaluation of the Stone Industrial Corporation
Copper-Plated Combustion Chamber Concept

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Emission Control Technology Division
Office of Air and Water Programs
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16. ABSTRACT Stone Industrial Corporation of College Park, Maryland, has had a long-term development project related to a copper-plated combustion chamber concept for reciprocating internal combustion engines. A majority of their experience with this concept has been with Diesel engines. Their work has shown reduction in Diesel smoke levels and some improvement in fuel economy. As an extension of this effort and to investigate the effect of their copper-plated combustion chamber concept in a light duty automotive application, Stone prepared two gasoline-powered vehicles. The Emission Control Technology Division was contacted by Stone in regard to conducting confirmatory testing on these vehicles. Emissions data from these vehicles presented by Stone demonstrated the potential of achieving low levels of all three emissions. Thus, test work was undertaken by the Test and Evaluation Branch.		
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Background

Stone Industrial Corporation of College Park, Maryland, has had a long-term development project related to a copper-plated combustion chamber concept for reciprocating internal combustion engines. A majority of their experience with this concept has been with Diesel engines. Their work has shown reduction in Diesel smoke levels and some improvement in fuel economy. As an extension of this effort and to investigate the effect of their copper-plated combustion chamber concept in a light duty automotive application, Stone prepared two gasoline-powered vehicles. The Emission Control Technology Division was contacted by Stone in regard to conducting confirmatory testing on these vehicles. Emissions data from these vehicles presented by Stone demonstrated the potential of achieving low levels of all three emissions. Thus, test work was undertaken by the Test and Evaluation Branch.

Device Description

Stone's concept involves plating of the piston crowns, valve faces, and cylinder head area exposed to the combustion chamber with a layer of copper on the order of one and one-half thousandths of an inch in thickness. Stone claims that the cuprous oxide film that develops on these surfaces helps to conserve and uniformly distribute heat within the combustion volume. This claim can be supported by the high reflectivity level of cuprous oxide in the infrared range (i.e., greater than 75% for wave lengths between 0.7 and 10.0 microns). In addition, cuprous oxide has a low level of thermal conductivity.

Two cars with the copper-plated combustion chambers were tested. One vehicle was a 1971 Ford Torino with a high compression ratio 351 CID engine. 50,000 miles had been accumulated on this vehicle with the modified combustion chamber. The other was a 1972 Ford Torino with a low compression ratio 351 CID engine. 18,000 miles had been accumulated on this vehicle with the modified combustion chamber. In addition to the plated combustion chamber, both vehicles were modified as follows:

- a) modified spark timing
- b) provisions for lean carburetion
- c) restricted choke action
- d) deceleration air bleed

Attached is a more detailed description, prepared by Stone, of these modifications.

Test Program

Three tests were conducted on each car in accordance with the 1975 Federal Test Procedure (FTP) as described in the November 15, 1972, Federal Register. All test work was conducted at 4000 lbs. inertia weight.

Results

The results from the tests are reported in the attached table. These results demonstrate that emission levels below 1975 interim standards can be achieved with this system. Good fuel economy was demonstrated during this testing. General impression of vehicle driveability was acceptable.

Conclusions

Stone Industrial Corporation's copper-plated combustion chamber concept with lean carburetion and spark timing modifications demonstrated the potential for achieving emission levels below 1975 interim standards. These vehicles, as equipped, also demonstrated good fuel economy with acceptable driveability. These vehicles did not, however, meet either the statutory 1975 or 1976 emission standards.

STONE TUNING MODIFICATIONS

The 1972 low compression 351 Cleveland Engine is equipped with a 12127 Motorcraft Distributor with a 73F134 vacuum retard especially made for Stone R & D by Ford Motor Company. The centrifugal weights have been changed to give an advance of 28° BTDC on acceleration, to maintain a 14° of advance at 2000 RPM cruising, and then to have a full retard on deceleration. The distributor is set up with a dwell of 29° + 2° at any range. The basic timing is 10° BTDC, in gear with vacuum disconnected and plugged, engine running at 640 RPM.

The carburetor is a 1971 Motorcraft, four barrel, D10FAAA. The main jets have been switched from No. 62's to 58's. The power valve is modified to open only when manifold vacuum is 7" Hg. or below. The accelerator pump is re-adjusted to give 1/3 of the pump stroke. An anti-stall dash pot is used to catch the throttle on deceleration so that the throttle plates do not close completely for approximately 8 seconds.

The choke is set very lean to hold the action time down on a cold start.

Added to the carburetor are two tubes at the vent holes and connected to a carbon canister to prevent fuel vapor boil over when the engine is shut off hot.

Under the carburetor we are using cylindrical, two ply screens, closed at the bottom, made of copper, for better vaporization of the fuel. This lets us run lean at idle and without misfire, and then a hot idle compensator is added to the carburetor.

The PVC valve is modified so that it doesn't close completely at any vacuum, but allows the maximum air in on deceleration.

The 1971 high compression 351 Cleveland Engine is equipped with a 12127 Motorcraft Distributor with a 73F134 vacuum retard especially made for Stone R & D by Ford Motor Company. The distributor is set to give an 18° BTDC advance on acceleration and 12° BTDC at Steady State 50 MPH 2200 RPM. The basic timing is 6° BTDC, all vacuum lines disconnected and an idle speed of 680 RPM.

With the retard line connected we have a timing of 10° ATDC, and 640 RPM.

The carburetor is a 1971 Motorcraft, four barrel, D10FAAA. The main jets have been switched from 62's to 55's. The power valve is modified to open only when manifold vacuum is 7" Hg. or below. The accelerator pump is re-adjusted to give 1/3 of the pump stroke. An anti-stall dash pot is used to catch the throttle on deceleration so that the throttle plates do not close completely for approximately 8 seconds.

The choke is set very lean to hold the action time down on a cold start.

Added to the carburetor are two tubes at the vent holes and connected to a carbon canister to prevent fuel vapor boil over when the engine is shut off hot.

Under the carburetor we are using cylindrical, two ply screen, closed at the bottom, made of copper for better vaporization of the fuel. This lets us run lean at idle without misfire, and then a hot idle compensator is added to the carburetor.

The PVC valve is modified so that it doesn't close completely at any vacuum, but allows the maximum air in on deceleration.

1975 FTP Results and Fuel Economy

Low Compression Ratio

	<u>HC</u> <u>gm/mi</u>	<u>CO</u> <u>gm/mi</u>	<u>NOx</u> <u>gm/mi</u>	<u>CO₂</u> <u>gm/mi</u>	<u>Fuel Consumption</u> <u>mpg (carb. bal.)</u>
Test 1	1.53	12.79	2.19	847.07	10.35
Test 2	1.37	13.13	2.12	799.97	10.88
Test 3	1.18	11.77	2.30	779.78	11.14
Avg.	1.36	12.56	2.20	808.94	10.79

High Compression Ratio

	<u>HC</u> <u>gm/mi</u>	<u>CO</u> <u>gm/mi</u>	<u>NOx</u> <u>gm/mi</u>	<u>CO₂</u> <u>gm/mi</u>	<u>Fuel Consumption</u> <u>mpg (carb. bal.)</u>
Test 1	1.04	9.31	2.30	772.06	11.33
Test 2	1.03	9.72	2.31	771.96	11.37
Test 3	1.04	9.63	2.49	768.01	11.39
Avg.	1.04	9.55	2.37	770.68	11.38

1975 Interim
Standard

1.5 15.0 3.1 --- ---

1976 Statutory
Standard

0.4 3.4 0.40 --- ---